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ABSTRACT

This study was designed to determine whether the scores obtained from the Kindergarten Diagnostic Instrument (KDI) Test given to children prior to their enrollment in kindergarten would allow educators to identify those children who would eventually qualify for a first grade reading intervention program. A total of 346 children were randomly divided into 2 groups, and the test scores for each group were analyzed with logistic regression models. The results for each group were cross-validated by determining the model's ability to correctly classify the children in the other group. The logistic regression analyses indicated that when the KDI Test scores were used as predictor variables, the models were not able to meet the statistical and practical criteria set in the study. Both models classified too many students as qualifying for the reading intervention who in fact did not qualify. (Six tables of data are included and 25 references are attached.) (Author/SR)

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Can the Kindergarten Diagnostic Instrument Be Used to Identify Children Who Will Qualify for a Reading Intervention Program?

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Abstract

This study was designed to determine whether the scores obtained from the Kindergarten Diagnostic Instrument (KDI) Test given to children prior to their enrollment in kindergarten would allow educators to identify those children who would eventually quality for a first grade reading intervention program. A total of 346 children was randomly divided into two groups; and the test scores for each group was analyzed with logistic regression models. The results for each group were cross-validated by determining the model's ability to correctly classify the children in the other group. The logistic regression analyses indicated that when the KDI Test scores were used as predictor variables, the models were not able to meet the statistical and practical criteria set in the study.

Can the Kindergarten Diagnostic Instrument Be Used to Identify Children Who Will Qualify for a Reading Intervention Program?

This study was undertaken to determine if the Kindergarten Diagnostic Instrument (KDI) (Robinson & Miller, 1986) could be used to identify those children entering kindergarten who would subsequently qualify for a reading intervention program in first grade. The advantage of identification at kindergarten entry is that it affords the opportunity for intervention with those children who are high risk for experiencing reading difficulties in first grade. Badian (1982) found that "early identification (before kindergarten entry if possible), followed by early special help in reading readiness and reading skills, has a beneficial effect in reducing the incidence of reading disability." Fraas and Crail (1992) found some support for using kindergarten measurements of student skills to identify which students would quality for a first grade reading intervention program.

The early identification of learning problems has been important to the development of remediation programs for children likely to experience difficulty acquiring reading skills. Early identification makes possible the construction and implementation of effective, developmental, and prescriptive

intervention programs which capitalize upon students' strengths and remediate weaknesses. A survey of reading disability (Strag, 1972) reported that when reading difficulties were diagnosed in the first two grades, nearly 82% of students could be brought up to normal classroom work. Success rate dropped to 46% for third grade and to only 10-15% for grades 5 to 7. Boehnlein (1987) reported the disturbing results that: "Children who do not learn to read by the end of first grade will fail to achieve in almost all other areas of the curriculum."

Kindergarten screening programs have been recognized as an effective tool in the early identification of children's strengths and deficits and in providing a framework for developing successful intervention practices for children at risk of experiencing reading difficulties (Molnar & Reighard, 1984). "Long experience with older educationally disabled children convinced (de Hirsch) that many of them would not have required help if their difficulties had been recognized at an early age" (de Hirsch, Jansky & Langsford, 1966).

It is argued that readiness should be viewed as a continuum. David Elkind (1987), President of the National Association for the Education of Young Children, suggests that "readiness is not something which exists in the child, but rather the degree of match between the child's modes of learning and

those required by the curriculum." In terms of early identification and reading mastery, this view suggests that children should be diagnosed for developmental competencies which correlate to the successful acquisition of reading skills. "Those who have them (these critical skills) [sic] can move forward into more specific reading skills; those who do not have the prerequisites need intensive instruction in what they are lacking" (Hillerich, 1975).

Correlations between measures administered in kindergarten or early first grade and level of reading achievement later in elementary school were examined by Horn and Packard (1985). A meta-analysis of the studies as cited in Gordon (1988) found that the best predictors of reading achievement were the following: (a) the child's ability to focus and sustain attention, (b) scores reflecting a low degree of internalized behavior problems, (c) level of general intellectual functioning, and (d) written expressive and/or receptive language. Horn and Packard (cited in Gordon, 1988) found that a very low magnitude of prediction was afforded by sensory tasks, i.e., figure drawing and neurological variables, i.e., handedness or gross motor skills.

Hillerich (1975) found that prerequisites for success in reading are those components of the curriculum which enable the individual to "function in the

language he will be expected to read. This implies both a receptive and an expressive command of oral English and its vocabulary and syntax which presumes the ability to discriminate sounds in words. The student must be able to think in the language and to comprehend ideas and to express ideas." These are often referred to as linguistic awareness skills and include sensitivity to the relationship between speech, language and reading; knowing what words and sentences are; being able to manipulate phonemes in words; and understanding the conventions of printed language (Lieberman & Shankweiler, in press). Denckle & Rudel (1976), Jansky & De Hirsch (1972) and Yule & Rutter (1976) report that the association of verbal and word-retrieval tasks with reading does find support from predictive research. The importance of language factors in dyslexic children were further documented by Mattis (1978) while Badian (1982) reports: "In view of mounting evidence that the majority of poor readers have a language disorder, it is not unexpected that naming tasks and other language variables were among the best predictors of reading."

There is another set of development skills that are thought by many to be central to reading acquisition and development. These skills, sometimes referred to as "auditory perceptual skills," assess the child's awareness of letters and corresponding sounds. Boder (1971) found that approximately 63%

of poor readers exhibited auditory problems. Research has shown these skills to be correlated to success in learning to read (Lieberman & Shanweiler, in press). It appears that good readers are good at auditory perceptual activities; poor readers are not, and reading achievement in the primary grades can be significantly delayed by auditory perceptual deficits (Weaver, 1976).

Badian (1982) found that the " ... five variables which were the best univariate predictors of reading skill and that were identified by stepwise regression techniques as the most effective short predictive battery, were all verbal or visual-verbal tasks. Skills such as automatic letter/word recognition, vocabulary knowledge, organizational skills, and prior "world" knowledge have been found to correlate to and interrelate with the reading comprehension processes (Weaver, 1976). General information or experiential knowledge should be assessed by predictive reading instruments. Recently, there has been an increase in research on the effects of prior knowledge in relationship to reading comprehension skills. In order to understand the things we read, we must have the appropriate background knowledge as a contextual frame of reference. "Whatever we learn, we learn by relating new ideas to what we have already experienced in our lives, and then we reformulate our old beliefs in light of the new ideas" (Buckley, 1987).

There is substantial research which supports the need to include visual discrimination and visual memory assessments in predictive reading instruments because comprehension and reading/decoding depend a great deal on rapid and accurate word/letter recognition and the interfacing of these skills with the other reading and comprehension subprocesses. Weaver (1976) suggests that the reader has to perform a combination of these subprocesses simultaneously and extremely rapidly for good comprehension to occur. Students who have poor decoding skills have to devote so much attention to decoding words that they do not have adequate resources to devote to comprehension.

"Readiness is not something which exists in the child, but rather the degree of match between the child's modes of learning and those required by the curriculum (Elkind, 1987)." In terms of early identification and predictive reading ability, this view suggests that children should be diagnosed for developmental competencies which correlate to the successful acquisition of reading skills. Consequently, it is to these ends and based upon the findings of the literature review presented that specific subtests of the KDI were selected and administered to children entering kindergarten in the Lexington Local Schools. This study examined the ability of eight specific subtests of the KDI to serve as a predictive instrument to identify those children entering

kindergarten who would subsequently qualify for reading intervention in first grade.

Methods

Setting and Subjects

The Lexington Local School District, which was the district used in this study, is located south/southwest of Mansfield, Ohio. Lexington is a suburb of approximately 5,500 people and is characteristic of a "bedroom community" having a high percentage of the professionals and business executives of the neighboring city, Mansfield, Ohio.

The Lexington Local School District's average daily membership (ADM) grades kindergarten through twelve is 2,759 students (Ohio Educational Directory, 1992). There are three elementary buildings (K-3, K-4, 5-6), one junior high school (7-8), and one high school (9-12). Approximately 2.2% of the students receive assistance from the Aid to Dependent Children Program (ADC) and 8.6% of the students are eligible for free to reduced priced lunches (Cox, 1992).

A sample of 346 students was selected for use in the study. The sample consisted of 167 males and 179 females. All of the 346 students had completed the KDI (Robinson and Miller, 1986) the spring prior to their entry

into kindergarten. Prior to their entry into first grade, they were classified as qualifying or not qualifying for the reading intervention programs, which were Chapter I and Reading Recovery.

Variables

Criterion Variable. The criterion variable was a dichotomous variable that indicated whether each student did or did not qualify for the first grade reading intervention program. A student was identified as qualifying for the program by scoring below the 36th percentile on the standardized total reading California Achievement Test (CTB McGraw Hill, 1986) given in kindergarten or through teacher recommendation. A value of 1 was assigned to those students who qualified for the reading intervention program; and a value of 0 was given to the students who did not qualify.

Predictor variables. The predictor variables consisted of eight subtest scores on the KDI test: (a) Auditory Memory, (b) Concept Mastery, (c) General Information, (d) Verbal Associations, (e) Verbal Opposites, (f) Visual Discrimination, (g) Visual Memory, and (h) Vocabulary. These variables were selected for use as the predictor variables based on a review of the reading literature and the recommendations of the reading-intervention program teachers.

Each subtest of the KDI used in this study can be briefly described as follows:

1. The Auditory Memory Subtest assesses the child's ability to recall words or sounds in the oral sequence in which they were presented.

2. The Concept Mastery Subtest measures the child's knowledge of basic concepts pertinent to the kindergarten curriculum (i.e., right, left, bottom, top, etc.).

3. The General Information Subtest assesses the child's knowledge of basic facts to which preschoolers typically are exposed and based upon prior knowledge, experiential development, and understanding.

4. The Verbal Associations Subtest evaluates the child's verbal reasoning skills through employing prior knowledge, conceptual understanding, and vocabulary.

5. The Verbal Opposites Subtest measures the child's verbal reasoning skills and the understanding of the concept "opposite."

6. The Visual Discrimination Subtest evaluates the visual perception and discrimination of various shapes and geometric forms and letter/word recognition.

7. The Visual Memory Subtest measures the child's visual

perception/recognition and memory/recall of previously observed shapes, letters, or words.

8. The Vocabulary Subtest assesses the child's specific conceptual understanding, experiential backgrounds, and prior knowledge of word meanings.

The eight subtest scores were used as the predictor variables in the two logistic regression models presented in the next section.

Data Analyses

Since the purpose of this study was to determine if the KDI test could be used for early identification of which students would qualify for the first grade reading intervention program, the criterion variable consisted of two categories. Thus, the data were analyzed with logistic regression models (Hosmer & Lemeshow, 1989; Judge, Griffiths, Hill, Lutkephol & Lee, 1985; Pinkych & Rubinfeld, 1991).

As a means of double cross validating the logistic regression models abilities to predict whether a student would or would not qualify for the reading intervention program, the sample of 346 students was randomly divided into two groups. The two groups did not statistically differ at the .05 level on the eight KDI scores and the percent of students who did qualify for

the reading program (see Table 1 and Table 2 for the descriptive statistics of the two groups).

Insert Tables 1 and 2 about here

A logistic regression model was used to analyze the data for each of the two groups. Three criteria were used to evaluate how well the logistic regression models were able to classify which students did or did not qualify for the reading intervention program. First, a chi-square value was used to test the difference between the quantities of -2 times the observed likelihood of the model that contained only the constant term and -2 times the observed likelihood of the model that contained the constant term and the eight predictor variables. This chi-square value was used to determine whether the null hypothesis that states that all of the coefficients of the predictor variables are equal to 0 should be rejected. For this test the alpha level was set at .05.

Second, the proportional chance criterion of correctly classifying students was also applied to the model. In the proportional chance criterion the proportion of students correctly classified by the model must be greater than the sum of the squares of the proportion of students in the two groups.

Again, as suggested by Hair, J., Anderson, R. & Tatham, R. (1987), the acceptable proportion of students correctly classified by the model had to be 25% greater than the proportional chance criterion value.

The third criterion used to judge the feasibility of using the models to classify the students related to practical significance. Since the pre-first-grade intervention program in which the identified students would be placed could accommodate a limited number of students, it was important for the model to produce few students who were identified by the model as needing reading assistance, but in fact they did not need such assistance. Thus, it was decided that for practical significance no more than 20% of the students identified as needing reading assistance by the model, would be misclassified.

In addition to the three criteria used to judge how well the logistic regression models were able to classify students, the Wald tests of the coefficients were reviewed to provide some insight into the influences of the predictor variables on the criterion variable. Each Wald test, which is equal to the square of the ratio of the coefficient to its standard error, was used to test whether the coefficient differed from zero. To protect against inflating the type I error rate, the alpha level used for each Wald test value was .00625, which was equal to .05 divided by the number of coefficients tested (8).

Results

Evaluating the model

The analyses of the logistic regression models for Groups 1 and 2 are contained in Tables 3 and 4, respectively. The chi-square value used to test the null hypothesis for Group 1 that all of the eight coefficients of the predictor variables were equal to 0 was 42.772 ($p < .001$). Since the probability value was less than the .05 alpha level, the null hypothesis was rejected. The chi-square value for the model used to analyze Group 2 was 37.092 ($p < .001$). Again, since the probability value for this chi-square value was less than .05, the null hypothesis that all eight of the coefficients were equal to 0 was rejected.

Insert Tables 3 and 4 about here

The logistic regression model used to analyze Group 1 was able to correctly classify 148 of the 174 students (85.1%) in Group 2, which served as the holdout group (see Table 5). Since 146 of the 174 students in the holdout group did not qualify for the reading intervention program, the proportional chance criterion was equal to .73. This value was calculated by summing the

square of the proportion of students in the holdout group who did not qualify for the program (.84 X .84 = .706) and the square of the proportion of students who did qualify for the program (.16 X .16 = .026). Since the proportion of students correctly classified by Model 1 (.851) was less than the figure that was 25% higher than the proportional chance criteria (.914), this criteria was not met by Model 1.

Insert Table 5 about here

The logistic regression analysis produced very similar results for Group 2. The logistic regression model used to analyze Group 2 was able to correctly classify 140 of the 172 students (81.4%) in Group 1, which served as the holdout group (see Table 6). The proportional chance criterion for this model was equal to .68. Since the proportion of students correctly classified by Model 1 (.814) was less than the proportion that was 25% higher than the proportional chance criterion (.85), this criterion was again not met for this group.

Insert Table 6 about here

If a logistic regression model is to be useful to the school system, it must not classify a high percentage of students as qualifying for reading assistance when in fact they would not qualify. The practical significance criterion was set at the level where no more than 20% of the students classified by the logistic regression model as needing reading assistance would be misclassified.

In Model 1, 14 students in the holdout group were classified as needing reading assistance. Six of these 14 students (43%) did not qualify for reading assistance (see Table 5). Thus, the ability of Model 1 to classify students did not reach the practical significance criterion. Similar results were obtained for Model 2. Eleven of the 24 students (46%) in the holdout group classified as needing reading assistance by Model 2 were misclassified (see Table 6). Again, the ability of Model 2 to classify students fell short of the practical significance criterion.

An examination of the Wald tests of the coefficients of Model 1 revealed that only the coefficient of the auditory memory variable was statistically significant at the .00625 alpha level. In Model 2 none of the coefficients was statistically significant at the .00625 level, although the significance level of the auditory memory coefficient was .022.

Conclusions

This study examined the ability of eight scores from the KDI test to identify which students would qualify for the first grade reading intervention program. The 346 students used in this study were randomly divided into two groups. The KDI scores of each group were subjected to a logistic regression model and the other group of students was used to determine the ability of the model to classify students as either needing or not needing reading intervention.

The results of the analyses indicated that Model 1 and Model 2 were able to correctly identify 85.1% and 81.4% of the students in the holdout groups, respectively. The proportion of students correctly classified by either model, however, was not able to exceed the proportion chance criterion by the required 25% figure. In addition, neither model was able to accurately classify students at a rate that could meet the practical significance level established in the study. That is, both models classified too many students as qualifying for the reading intervention program who in fact did not qualify.

Based on the results of this study, it was concluded that the KDI test could not be used in isolation to identify at an early stage in kindergarten those students who would qualify for the first grade reading intervention program for

the students in the Lexington School District. The KDI test may be useful for this purpose as one of a number of pieces of information on which such classifications are made. Another source of information that may improve the ability of the school administrators and teachers to identify whether a student will qualify for the first grade reading intervention program is an evaluation of the student by the kindergarten teacher that is made during the first half of the kindergarten year. This avenue of investigation is worthy of future study when the school system has deemed the early identification of students who will need reading assistance as an important educational goal.

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Table 1

Descriptive Statistics for the Group Analysed by the Logistic Regression Model 1

Variable	Mean	Standard Deviation
Group Membership	.20*	---
Auditory Memory	10.22	4.74
Concept Mastery	10.27	2.66
General Information	5.66	2.37
Verbal Associations	4.41	2.43
Verbal Opposites	5.56	2.17
Visual Discrimination	15.34	3.76
Visual Memory	6.28	1.48
Vocabulary	15.85	3.52

Note. *Indicates that 20% of the students qualified for the program.

n=172.

Table 2

Descriptive Statistics for the Group Analysed by the Logistic Regression Model 2

Variable	Mean	Standard Deviation
Group Membership	.16*	---
Auditory Memory	9.96	4.84
Concept Mastery	10.02	2.80
General Information	5.78	2.47
Verbal Associations	4.57	2.38
Verbal Opposites	6.11	2.06
Visual Discrimination	15.67	3.38
Visual Memory	6.40	1.45
Vocabulary	16.02	3.80

Note. *Indicates that 16% of the students qualified for the program.

n=174.

Table 3

Logistic Regression Model 1

Variable	Coefficient	S.E.	Wald	DF	Sig
Auditory Memory	-.221	.075	8.67	1	.003
Concept Mastery	-.016	.111	.02	1	.890
General Information	.120	.133	.81	1	.368
Verbal Associations	-.284	.132	4.68	1	.031
Verbal Opposites	-.091	.143	.40	1	.527
Visual Discrimination	.012	.078	.02	1	.881
Visual Memory	-.128	.168	.58	1	.445
Vocabulary	.010	.068	.02	1	.883
Constant	1.982	1.320	2.26	1	.133

Note. The -2 log likelihood value for the full model is 128.251.

The -2 log likelihood value for model with only the constant term is 171.026.

The model chi-square = 42.772. df=8. p<.001.

Table 4

Logistic Regression Model 2

Variable	Coefficient	S.E.	Wald	DF	Sig
Auditory Memory	-.184	.080	5.25	1	.022
Concept Mastery	-.083	.098	.72	1	.397
General Information	-.008	.143	.00	1	.945
Verbal Associations	-.120	.150	.64	1	.426
Verbal Opposites	-.074	.160	.22	1	.642
Visual Discrimination	-.141	.080	3.14	1	.076
Visual Memory	-.036	.181	.04	1	.843
Vocabulary	-.030	.073	.17	1	.680
Constant	4.284	1.564	7.50	1	.006

Note. The -2 log likelihood value for the full model is 116.44.

The -2 log likelihood value for model with only the constant term is 153.53.

The model chi-square = 37.092. df=8. p<.001.

Table 5

Correct Classification for the Holdout Group 2 with Logistic Regression Model 1

Actual Group Membership	Predicted Group Membership: Did Not Qualify	Did Qualify	Total	%
Did Not Qualify	140	6	146	95.9
Did Qualify	20	8	28	28.6
Total	160	14	174	85.1

Table 6

Correct Classification for the Holdout Group 1 with Logistic Regression Model 2

Actual Group Membership	Predicted Group Membership: Did Not Qualify	Did Qualify	Total	%
Did Not Qualify	127	11	138	92.0
Did Qualify	21	13	34	38.2
Total	148	24	172	81.4